REMARKS / ARGUMENTS:

The remarks below are in response to the final Office Action mailed September 19, 2008. Applicants, having fully considered the issues raised therein, and in view of the following remarks, request reconsideration of the application. Withdrawal of the rejections and issuance of a Notice of Allowance are specifically requested.

Applicants submit the amendments to Claim 103 are to correct inadvertent typographical errors. Accordingly, no new issues are presented. Applicants request, therefore, reconsideration of the claims after issuance of a Final rejection.

Claim Rejections – 35 U.S.C. § 112, First Paragraph

The Examiner rejected claims 103, 106, 108, 109, 112, 117, 135, 138, 140, 142, 143, 153, and 155 – 158 under 35 U.S.C. § 112, first paragraph, as being unpatentable for failing to comply with the written description requirement. Applicants respectfully traverse the rejection.

According to the Examiner, the recitation of beans selected from the genera Vigna, Glycine, Vicia, and Phaseolus not being affected by Take-all disease is new matter. The Examiner continues, stating, "The specification discloses that soybean is not affected by Take-all disease. No other beantype or bean genus is mentioned as not being affected by Take-all disease."

Applicants submit the specification fully supports the inclusion of each of these genera (at pages 9, 10 and original claim 20) in the claimed method, and, as recognized by the Examiner, the specification clearly states that soybeans are not affected by Take-all disease.

All recited genera are beans in the sub-family Faboideae and share significant common metabolic pathways. Due at least to the close generic relationship of the claimed plants and shared biological pathways, one having ordinary skill in the art would, upon understanding that soybeans are not affected by Take-all disease as stated in the present specification, expect that the members of these genera also would not be affected by Take-all disease.

Moreover, it is known in the art that legumes are not affected by Take-all disease. Such knowledge is evidenced by the attached information sheets from the

University of Missouri, Oregon State University, and Australia's CSIRO Land and Water. Each of these information sheets is dated prior to the filing date of the present application and each discloses that legumes are not susceptible to Take-all disease.

Accordingly, a specific disclosure that the broader class of beans is not susceptible to Take-all disease is not necessary, because this information was known in the art prior to the filing of the present application.

Consequently, the present claims are supported to their full scope by the specification as originally filed. Applicants request, therefore, withdrawal of the rejections under 35 U.S.C. § 112, first paragraph.

Provisional Rejection – Obviousness-type Double Patenting

The Examiner provisionally rejected claims 103, 104, 106, 108 – 110, 112 – 114, 116 – 118, 120, 122 and 134 – 158 under the doctrine of nonstatutory obviousness-type double patenting over claims 111 – 113, 115 – 117 and 122 – 125 of copending Application No. 11/138,965 as published in U.S. Patent Application Publication No. 2005/0233905. Applicants respectfully traverse the rejection.

Reconsideration of the provisional double patenting rejection (nonstatutory) of claims 103, 104, 106, 108 – 110, 112 – 114, 116 – 118, 120, 122 and 134 – 158, in view of claims 111 – 113, 115 – 117 and 122 – 125 of copending Application No. 11/138,965, as published in U.S. Patent Application Publication No. 2005/0233905, is respectfully requested for the reasons asserted in the Applicant's Response dated February 2, 2007. For convenience, Applicants repeat the arguments below.

In response to the present rejection, Applicants respectfully call the Office's attention to MPEP §804, I., B., which states:

> The "provisional" double patenting rejection should continue to be made by the examiner in each application as long as there are conflicting claims in more than one application **unless** that "provisional" double patent rejection is the **only** rejection remaining in at least one of the applications.

If a "provisional" nonstatutory obviousness-type double patenting (ODP) rejection is the **only** rejection remaining in the earlier filed of the two pending applications, while the later-filed application is rejectable on other grounds, **the examiner should withdraw that rejection and permit the earlier-filed application to issue as a patent** . . . (Emphasis added)

After the withdrawal of the single ground of rejection discussed above, this double patenting rejection is the only rejection remaining in the present application and, therefore, Applicants submit that this rejection should be withdrawn, consistent with the clear language of the MPEP.

Sander's Declaration:

The Office previously stated that the Declaration submitted by the Applicants under 37 CFR §1.132 on Feb. 5, 2007, cannot be used to show enablement because it contains data that were collected after the filing date of the application. Applicants maintain that this is an incorrect statement of law and request correction or clarification on the record by the Office. Applicants appreciated the concurrence of the Examiner with this position in the interview of April 29, 2008 and request that such concurrence be made of record.

Applicants submit that, in view of the above remarks, the application is in condition for allowance. Withdrawal of the rejections and issuance of a Notice of Allowance is, therefore, respectfully requested.

It is believed that no fees are due in conjunction with the filing of the present response. If, however, it is determined that fees are due, authorization is hereby given to deduct those fees from Deposit Account No. 50-2548.

If one or more of the claims are found to not be allowable, a telephone call to the undersigned would be appreciated in order to resolve any remaining issues.

Respectfully submitted,

Nelson Mullins Riley & Scarborough, LLP

Dated: January 16, 2009

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Wheat Take-all

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Take-all is a disease of the roots, crown, and stem base of wheat. It interrupts plant development and may seriously suppress yields. A common problem of winter wheat in North America, Take-all occurs in Missouri especially under cool, damp conditions. The name originated in Australia in the middle of the last century when the disease "took all" seedlings it attacked. In Missouri the disease seldom affects seedlings but more commonly attacks wheat plants at the tillering stage.

Yield losses to this disease in Missouri vary yearly depending on environmental conditions. Light to moderate damage may often go undetected. If soil and weather conditions favor the disease, severe root and crown rot develop, and yields may drop more than 50 percent.

Take-all is caused by the fungus Gaeumannomyces graminis. It infects wheat, barley, rye and several grasses, including smooth bromegrass (*Bromus* spp.), quackgrass (*Agropyron* spp.) and bentgrass (*Agrostic* spp.).

Symptoms

Most plants withstand mild root infections and appear symptomless. Severely infected plants are stunted and ripen prematurely. Take-all symptoms are most obvious near heading, when plants appear uneven in height (Figure 1), begin to die prematurely, and exhibit white heads (Figure 2). Infected plants may be stunted, mildly off color (yellow) and have fewer tillers. When tillers are killed prematurely, their heads are distinctly bleached (white-headed) and sterile. Diseased plants are easily pulled up or break off near the soil line because of root rot. On close examination, their roots appear sparse, blackened, and brittle (Figure 3).

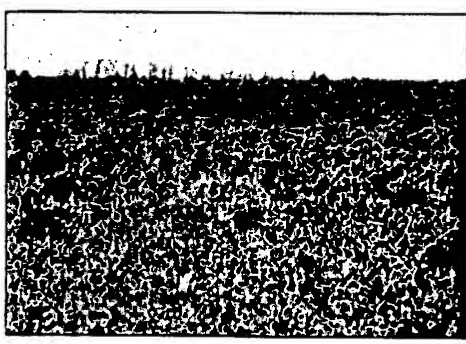


Figure 1
Patches of stunted wheat are a symptom of severe Take-all infection

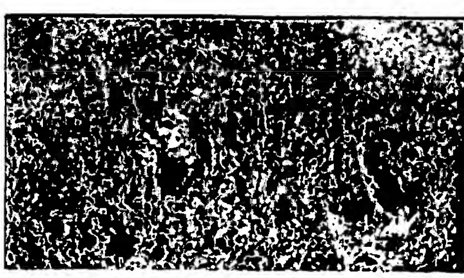


Figure 2
Plants affected by Take-all develop white heads and die prematurely

Figure 3
Plants affected by Take-all have darkened stem bases and black, brittle roots

Symptoms may be limited to blackened roots if soil moisture is low early in the development of the crop. If there is sufficient soil moisture throughout the growing season, the black-brown rot may extend into the crown and up the stem base, where a superficial, dark, shiny layer of the fungus surrounds the stem beneath the lowest leaf sheath. Diseased stems weakened at their base may occasionally lodge, or lie flat on the ground. Although these symptoms are often the first obvious indications of Take-all, they are the terminal stages of the disease.

Disease cycle

The Take-all fungus survives from year to year on the undecomposed root and crown residue of infected plants. It can be spread from area to area in this debris. Healthy plant roots become infected as they grow through soil near infected wheat debris. Infection occurs when the fungus penetrates the young roots of a living plant. Infection occurs throughout the growing season but is more severe when the temperature is between 54 degrees and 64 degrees Fahrenheit. Damage is usually greater when plants are infected in the autumn or early spring. Damage may not be visible when plants are infected in late spring rather than early spring.

Conditions that favor Take-all

Take-all is more severe in sandy, alkaline, infertile, and poorly drained soils. Wet soils, especially during the second half of the growing season, favor Take-all development. Symptoms are less noticeable under dry soil conditions.

Take-all severity on wheat depends on the supply of nutrients to the host. It is important, therefore, to maintain good levels of available nitrogen, phosphorus, potassium and magnesium.

Soil pH affects the development of this disease. Disease damage is usually worse as the soil pH approaches 7.0. Thus, applications of lime and nitrate fertilizers (that raise the pH around plant roots) generally increase the severity of Take-all. Ammoniacal and slow-release forms of nitrogen are less favorable for disease development. Also, the severity of Take-all seems less when nitrogen is applied in the spring than in the fall.

The sudden development of whiteheads after a period of hot, dry whether gives the impression that the disease develops late in the season and is favored by hot, dry conditions. However, root and stem damage occurs much earlier, and hot, dry weather serves only to accelerate ripening and water stress. The pathogen rapidly becomes inactive at any stage in the disease cycle during dry weather.

Control

Wheat varieties highly resistant to Take-all are not available. Thus, other disease control techniques must be used.

Rotate crops so a field is out of wheat for one to three years and in a crop that is not infected, such as corn, forage legumes, milo, oats, or soybean. This is usually sufficient for disease control. The fungus needs a host, such as wheat, to thrive on and will die without it. Double cropping wheat and soybean is not a useful rotation for Take-all control. In this situation, the disease develops on the wheat. In problem fields, do not plant wheat as a winter cover crop. The fungus can infect the winter wheat cover crop and thus remain in the soil.

Maintain optimum soil fertility to help reduce the severity of the disease. Adequate nitrogen, phosphorus,

potassium and magnesium are needed to promote root and plant growth.

Other management techniques that may be useful include:

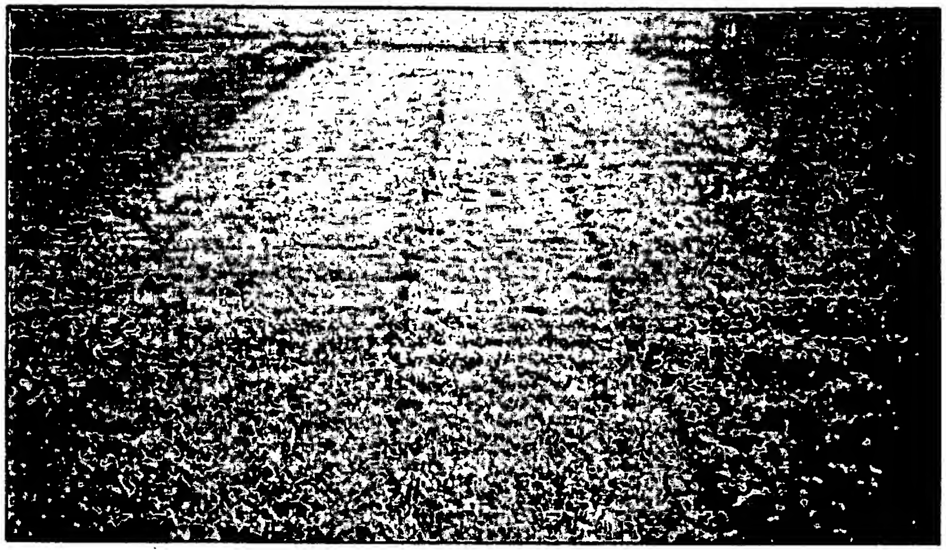
- **Eradicating** wild grass hosts (quackgrass, wild barley, or downy brome) and volunteer wheat.
- **Improving drainage** (Take-all is more severe in wet areas).
- **Delaying fall planting** (The disease is usually worse on early wheat than on late-planted wheat).

The disease is not reduced by burning wheat stubble. Reports on the benefits of seed treatment with Baytan for Take-all contol have been variable.

G4345, revised December 1997

Research Project
Information from
CSIRO
Land and Water

Series No. 3
November 1997



Control of Take-all in the Pasture Phase of Rotations

Introduction

The disease, take-all, caused by the fungus *Gaeumannomyces graminis* var. tritici was first referred to in 1852 in South Australia. Reports of losses from wheat crops as a result of "take-all" became common in the 1920's and 1930's, particularly on the lighter soil types typical of the Mallee environments in Australia. In the same period, the first cases of take-all were reported from U.S.A. and the U.K. Since the 1970's, Korea and China have been added to the list of countries that suffer from this disease. Today, take-all is one of the most significant diseases of cereals and is found in all cereal-growing countries of the world.

Across southern Australia, take-all infection of cereals reduces grain yields by approximately $100 million annually. In severe cases (> 50% plant infection) farmers will see the symptoms of this disease as "white heads" appearing in their paddocks, but in many cases, due to lower levels of take-all, farmers will not be aware of the insidious presence of the disease yet crop yields may be significantly reduced.

Research

There are a number of take-all control measures; crop rotation with a non-host (pulses, oil seed, pasture legume or oats), or removal of host grasses from pastures. Work at CSIRO Land and Water has centred on (a) determining the correct timing of herbicide application to pastures, (b) the likely success of various take-all control measures given the rainfall environment, and (c) the relative importance of annual pasture grass species in the build-up and carry-over of take-all.

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(a) Timing of grass removal.

Research has shown that in high rainfall environments (>400 mm annual rainfall), herbicides need to be applied by mid July, and in low rainfall environments (< 400 mm annual rainfall), by the end of June. Soil-bome organisms have the ability to break down take-all infected material, but only if there is sufficient moisture in the soil and adequate time to allow this activity; thus, early grass removal is a critical aspect of successful grass control.

Care needs to be taken with the herbicide used. Selective herbicides are more consistent in their control of grasses but take longer to cause grass death than non-selective herbicides, therefore reducing time for the activities of soil-borne organisms. In addition, some herbicides are unable to remove silver grass, requiring the addition of Simazine to the take-all mix. Farmers should also be aware that non-selective herbicides can damage pasture legumes if application rates are too high. Farmers planning to remove grasses also need to ensure that sufficient pasture legume (clover/medic) exists in the pasture (a minimum of 15% of total pasture composition) to remove the risk of erosion and to provide grazing, nitrogen fixation and seed set for following years.

(b) Importance of rainfall environment.

Rainfall environments with greater than 400 mm annual rainfall have the full range of control options available (all break crops, oats and grass removal with herbicides). This is not the case in lower rainfall environment (<400 mm annual rainfall), where cultivation of grain legumes or oil seeds is made uneconomic or not viable due to low rainfall, necessitating a reliance on oats or diligent use of grass removal techniques. In addition to the rainfall environment, the timing of the opening rains can impact on the likelihood of success of herbicide application, particularly in a season with a late break, where premature reduction in soil moisture reduces time for soil-borne activity on take-all infected material.

(c) Hosting ability of common pasture grasses.

Results of extensive surveys of pasture sites across Victoria and South Australia show that significant variation exists between the various grass species. As a general guide, barley grass is approximately 50% greater than brome or silver grass and 100% greater then rye grass in its ability to host and carry-over take-all. It is therefore critical that densities of barley grass particularly, but also densities of brome and silver grass, are reduced to less than 50 plants per sq. metre following herbicide application.

Recommendations

1. In higher rainfall environments (>400 mm annual rainfall) grasses should be removed by mid July and in lower rainfall environments (<400 mm annual rainfall), grasses should be removed by the end of June.
2. Consider the timing of opening rains and the likelihood of sufficient time for break down of take-all infected material, this assessment may indicate that the application of herbicides may be inappropriate.
3. Following herbicide application, assess pasture paddocks individually for the residual grass species composition to determine the success of grass removal treatments.

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Combatting take-all of winter wheat in western Oregon

N.W. Christensen and J.M. Hart

Take-all disease of wheat is caused by the soil-borne fungus *Gaeumannomyces graminis* var. *tritici* (*Ggt*), which infects the roots, crown, and basal stem of plants. Take-all is common in western Oregon whenever consecutive crops of wheat are grown. Grain yield may be reduced by as much as 50 percent in second or third crops of winter wheat.

Symptoms are most obvious near heading and include stunting or uneven growth, poor tillering, blackened roots and crowns, premature ripening, and white heads with few kernels. Root systems of severely infected plants may be sparse, brittle, and exhibiting black lesions that extend to the crown and basal stem.

There are no economically effective fungicides and no varieties exhibit resistance to take-all. Where take-all is anticipated, disease control in winter wheat requires implementing specific soil and crop management practices beginning with planting and extending through early summer.

This publication identifies factors that influence the severity of take-all and recommends management practices to minimize losses to the disease in western Oregon. Management suggestions in *Recommendations* are based on more than 10 years of research and have been successfully implemented by growers.

Few if any corrective measures are available after identifying a severe take-all infestation. Growers should assess the risk of take-all and adopt a package of management practices to minimize yield losses when the risk of disease is high. *Disease development and management* provides data and details about management practices to slow take-all development and minimize yield losses.

Disease development and management

Soil temperature, soil water content, and soil and crop management practices influence take-all disease and associated yield losses in western Oregon. While weather conditions cannot be controlled, there

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Neil W. Christensen, professor of soil science, and John M. Hart, Extension soil scientist, Oregon State University.

OREGON STATE UNIVERSITY EXTENSION SERVICE

are a number of management practices that can slow disease development and maintain grain yield. These include cropping history and rotation, weed control, stubble management, planting date, soil pH and liming, fall and spring fertilization, and control of other diseases. Management practices interact with environmental conditions, and each other, to determine the severity of take-all and the magnitude of yield loss. Since one or more of these factors may govern disease severity, we cannot always predict which factors will be most important in any given year.

Cropping history and rotation

Crop rotation is the best way to control take-all. The pathogen persists in infected host debris, which serves as the primary source of inoculum for infection of subsequent wheat crops. Survival of the fungus in the absence of a host is poor. A 1-year break from wheat or barley is usually sufficient to reduce the take-all risk to an insignificant level. Suitable break crops include oats, corn, beans, vegetables, oilseed crops, and annual legumes for seed.

The highest risk of take-all occurs when wheat is planted in consecutive years. Disease severity and yield loss can be substantial in second, third, and fourth wheat crops, with the worst take-all usually occurring in the third consecutive crop. Take-all becomes less severe, and yields usually increase, with the fifth or sixth successive wheat crop. This occurs because of a natural increase in soil microorganisms antagonistic to the pathogen—a phenomenon known as "take-all decline," which persists only so long as wheat is grown continuously.

Some growers have been caught off-guard by crop rotations that appear to be low-risk and yet unexpectedly develop severe take-all. One such rotation is winter wheat–sweet corn–winter wheat, in which volunteer wheat from the first crop is allowed to over-winter as a cover crop.

The 5-month break when corn is grown is insufficient to reduce the inoculum potential of the infested residue. The severity of take-all in the second crop of wheat can be comparable to that seen in second or third crops of continuous wheat.

Figure 1.—*Severity of take-all as influenced by time after spring topdressing with urea, ammonium nitrate, ammonium chloride or ammonium sulfate on: (a) 2nd-year wheat in 1986, (b) 3rd-year wheat in 1988, and (c) 4th-year wheat in 1988. Nitrogen fertilizers were topdressed on March 1, + or – 7 days.*

Weed control and stubble management

The take-all fungus (*Ggt*) invades wheatgrass and quackgrass (*Agropyron* spp.), bromegrass (*Bromus* spp.) and bentgrass (*Agrostis* spp.), as well as wheat and barley. Like volunteer wheat or barley, grassy weeds can harbor the pathogen. These weeds may contribute to unexpected disease outbreaks when first-year wheat follows a legume crop infested with host grasses. Killing grassy hosts with tillage or herbicides within a few months of planting wheat may not reduce the risk of take-all since *Ggt* persists in host debris. We recommend advance, long-term control of grassy hosts for rotations including wheat.

Chopping stubble followed by plowing to a depth of 8 inches buries and reduces the size of host crop residues that serve as the primary inoculum source for subsequent crops. This delays or minimizes seedling infection and increases the probability that other control measures will slow disease progress. The impact of minimum-till or no-till on take-all has not been studied in western Oregon. However, data from other regions suggest a higher risk of take-all with reduced tillage.

Figure 2.—*Winter wheat grain yield as influenced by the number of take-all infested crown roots at anthesis: (a) seven experiments in four seasons; (b) by year for ammonium nitrate, ammonium sulfate and urea treatments; and (c) by N fertilizer in 1986-88.*

Take-all development

Roots become infected as they grow through soil near infested debris and are colonized superficially before being penetrated by the fungus. Infection can occur throughout the growing season and is favored by moist soils having temperatures of 50 to 68° F. These conditions prevail for much of the growing season in western Oregon. Autumn and early-spring root infections are most likely to progress to the crown. Diseased crown roots usually increase exponentially from late February through late May in western Oregon.

Figure 1 illustrates this increase in disease severity. It shows that seasonal environment, nitrogen (N) fertilizer source, and number of years in wheat all affect the rate of disease development.

These results demonstrate the importance of adopting take-all control management practices far in advance of symptom development in any given year. At the time that N fertilizer should be topdressed in the spring for maximum benefit (Feekes Stage 5; approx. March 1), few if any crown roots are infected, and you cannot predict whether take-all will be mild (*e.g.*, 1986) or severe (*e.g.*, 1988).

Figure 1 also illustrates that the late-February choice of N fertilizer can make nearly a two-fold difference in the severity of take-all in late May. For example, 88 days after spring fertilization in 1988, plants fertilized with urea or ammonium nitrate had an average of 12 infected crown roots per tiller as compared to an average of 7 for plants fertilized with ammonium chloride or ammonium sulfate (figure 1c). Year-to-year rainfall and temperature differences and the choice of N fertilizer generally have greater effects on take-all severity than does the number of years wheat has been grown.

Yield loss to take-all

In western Oregon, the extent of crown-root infection at anthesis or flowering (late May) establishes the potential for take-all yield loss. Soils are generally dry enough by early June to arrest further development of the disease. Consequently, yield losses in any given year depend upon take-all severity at anthesis, weather conditions in June and July, and whether a chloride (Cl^-) containing fertilizer was applied in the spring.

These effects can be seen in Figure 2, illustrating the overall relationship between grain yield and disease severity at anthesis. It also shows the relationships for different seasons and different N fertilizers topdressed in late-February or early-March.

Figure 2**a** shows that for each take-all infested crown root per tiller, grain yield was reduced by 2.9 bu/acre on average. Thirty-five percent of the variability in grain yield in seven experiments over four crop-years was explained by the number of take-all infested crown roots at anthesis.

Up to 59 percent of the variability in grain yield was explained by taking seasonal variability (figure 2**b**) and N fertilizer source (figure 2**c**) into consideration. Regression lines in Fig. 2**b** show that maximum take-all severity was less in 1986 and 1987 than in 1984 and 1988.

Despite the similarity in maximum disease severity in 1986 and 1987, grain yield losses to take-all were much greater in 1987 (−3.8 bu/acre per infected root) than in 1986 (−1.5 bu/acre per infected root), probably because of higher summer temperatures and greater water stress on plants in 1987.

Similarly, figure 2c (and figure 1) shows that take-all severity was greater with urea and ammonium nitrate fertilizers than with ammonium chloride and ammonium sulfate fertilizers. Figure 2c also shows that yield losses to take-all were less when the crop was topdressed with a chloride containing fertilizer (−1.0 bu/acre per infected root) as compared to N fertilizers without chloride (−2.4 bu/acre per infected root). Apparently, chloride-fertilized plants have an increased tolerance to take-all.

Soil pH and liming

Increasing the pH of moderately acid soils through liming generally increases the severity of take-all and reduces grain yield (Table 1). Other management practices such as application of ammonium-N (NH_4^+) plus chloride in the spring are more effective in controlling take-all when soil pH is near 5.5.

In contrast, soils with pH 5.2 or less, especially those with low phosphorus (P) soil tests, may respond favorably to liming. Liming an acid, low-P Nonpareil soil (pH 5.2, 12 ppm P) increased yield of third-year wheat from 30 to 64 bu/acre and decreased the percentage of whiteheads (a symptom of take-all) from 63 to 14 percent. When pH-sensitive crops are grown in rotation with two or more years of wheat, lime should be applied after the last wheat crop is harvested.

Planting date

On well-drained valley-floor soils, delaying planting until late October can reduce early take-all infection of seedlings and increase grain yield, especially if other disease control measures are practiced (table 2). Be careful, however, because of the risk of fall rains. *Do not* delay planting on valley-floor soils with reduced drainage or on hill soils. A survey of 126 growers reporting results from 495 fields showed that planting after October 12 reduced yields by 14 to 26 bu/acre on hill or poorly-drained soils.

Fertilizer management

Nutrient deficiencies at any time during the growing season will increase the severity of take-all. Ensuring that N, P, sulfur (S), and potassium (K) are adequate at planting

Table 1.—*Liming (soil pH) and N fertilizer effects on winter wheat grain yield on moderately acid soils with a high risk of take-all.*

Spring N source	Soil pH† 5.5	6.0	6.2	Soil pH‡ 5.5	6.5	Soil pH¶ 5.5	6.0
	bu/acre						
Ammonium nitrate	n.a.	n.a.	n.a.	n.a.	n.a.	93	70
Ammonium sulfate	67	60	61	52	57	112	94
Ammonium chloride	85	75	65	70	56	114	96
LSD (P=0.05)		10		9		5	

† 'Hyslop' planted 27 Oct. 1977 on Willamette soil topdressed with 120 lb N/acre in spring 1978.
‡ 'Hill 81' planted 3 Nov. 1982 on Woodburn soil topdressed with 120 lb N/acre on March 15, 1983.
¶ 'Hill 81' planted 20 Oct. 1983 on Woodburn soil topdressed with 160 lb N/acre on March 6, 1984.

Table 2.—*Planting date and nitrogen source effects on winter wheat grain yield on two well drained soils with a high risk of take-all.*

Spring N source	Willamette sl† 4 Oct.	27 Oct.	Woodburn sl‡ 15 Oct.	25 Oct.
	bu/acre			
Ammonium sulfate	43	65	58	60
Ammonium chloride	56	76	67	80
LSD (P=0.05)	8	4	9	9

† 'Hyslop' winter wheat topdressed with 120 lb N/acre in spring of 1978.
‡ 'Stephens' winter wheat topdressed with 120 lb N/acre on March 16, 1981.

Table 3.—*Spring-topdressed N fertilizer effects on grain yield in 19 experiments.*

Spring N source†	1978 (2)	1980 (3)	1981 (3)	1982 (1)	1983 (1)	1984 (4)	1986 (2)	1988 (2)	1989 (1)
	Year of harvest (number of experiments)								
	bu/acre‡								
Urea	n.a.	n.a.	n.a.	n.a.	n.a.	111a	93a	86a	144ab
Am. Nitrate	n.a.	n.a.	n.a.	n.a.	85a	109b	94ab	93b	141ab
Am. Sulfate	54a	88a	66a	52a	106b	111a	99b	98b	138a
Am. Chloride¶	66b	107b	80b	70b	106b	111a	107c	116c	151b

† Topdressed at rates of 120 (1978, 1980, 1981), 125 (1983) or 160 lb N/acre (1984-89) by Feekes Stages 4 to 7.
‡ Within-column means followed by the same letter are not siginificantly different at P = 0.05. (For instance, 138a and 151b are not significantly different than 141ab, but they are signficantly different than each other.)
¶ Experimentally equivalent to ammonium sulfate (21-0-0) plus KCl (0-0-60) to supply at least 100 lb Cl/acre.

Recommendations

Few if any corrective measures are available after identifying a severe take-all infestation. The following recommendations will minimize yield loss to take-all when successive wheat crops are planted for less than 5 years. Refer to "Disease Development and Management" for details, explanations, and data about management practices that slow take-all development and minimize yield loss.

Pre-plant management

Liming A soil pH of 5.5 is desirable for combatting take-all. Apply lime only if the soil pH is 5.2 or less.

Stubble Chop stubble and plow deeply to bury the inoculum.

Planting

Planting date On well-drained valley-floor soils, delay planting until late October if possible. *Do not* delay planting beyond mid-October on hill soils or valley-floor soils with reduced drainage. For more information on wheat production on poorly drained soils, read FS 269, *Growing Winter Wheat on Poorly Drained Soil.*

Fertilization Band 20 to 30 lb N/acre in ammonium form, 30 to 50 lb P_2O_5/acre, and 10 to 15 lb S/acre. Apply 25 to 30 lb K_2O/acre if a soil test indicates the need for K.

Growing season

Fertilization Apply 140 to 180 lb N/acre as ammonium sulfate plus 100 lb Cl/acre as KCl before Feekes growth stage 5. Alternatively, apply 40 lb N/acre and 100 lb Cl/acre at late tillering (Feekes 4; mid-Feb.) and the remaining N within 3 to 4 weeks, but before jointing (Feekes 6). For more information on spring fertilization of wheat see FG 9, *Winter Wheat (Western Oregon).*

Weed Control Control weeds to minimize competition with wheat for nutrients and moisture.

Disease Control Control leaf diseases such as septoria and other root diseases by using resistant cultivars or fungicides to ensure maximum benefit from other aspects of this management plan to reduce yield loss from take-all. Read and follow fungicide label directions.

is especially important. Do this by banding N-P-S or N-P-K-S fertilizers with the seed when the risk of take-all is high.

Apply nitrogen in the ammonium form (NH_4^+), rather than as nitrate (NO_3^-), because NH_4^+-N uptake reduces rhizosphere pH and favors growth of microorganisms antagonistic to the take-all fungus. Routinely apply P since P deficient plants are more susceptible to take-all, and infected seedlings have poorly functioning root systems.

When take-all is present, wheat will respond to banded P fertilizer on soils where no response would be expected in the absence of take-all. For example, grain yield increased from 56 to 65 bu/acre (LSD @ 5% = 7.3) when P was banded with the seed on a Willamette soil testing 125 ppm P. Sulfur is more often deficient for wheat in western Oregon than is K and should be routinely applied at planting.

As figures 1 and 2c show, spring-topdressed N fertilizers can influence the severity of take-all and, thus, grain yield (Table 3 on the preceding page). Yields are generally higher with ammonium chloride than with ammonium nitrate or urea. Ammonium sulfate (21-0-0) was common to all experiments and was assigned a relative value of 100 percent in calculating average relative yield for each N fertilizer.

On average, grain yield with ammonium nitrate (34-0-0) or urea (45-0-0) was slightly less (94 to 96 percent) than with ammonium sulfate. Fertilization with ammonium chloride, as compared to ammonium sulfate, significantly increased grain yield in seven of nine growing seasons for an average relative yield of 115 percent.

This compares favorably with results of a survey of 126 growers who reported average responses to chloride of 18 percent or 12 bu/acre. In research trials, test weight of wheat fertilized with ammonium chloride (59.7 lb/bu) was consistently higher than test weight of wheat fertilized with other N fertilizers (58.7 lb/bu).

Because ammonium chloride is no longer available in western Oregon, use ammonium sulfate *plus* potassium chloride (KCl) to supply ammonium-N and chloride. For comparable yield and test weight responses, sufficient KCl to supply at least 100 lb Cl/acre should be topdressed with ammonium sulfate. Ammonium-N and chloride should be applied by Feekes Growth Stage 5 if you are making only a single fertilizer application.

Control of other diseases

The effectiveness of crop and soil management to minimize yield losses to take-all is reduced when other plant diseases threaten the wheat crop. Common diseases that may need further control measures include strawbreaker foot rot caused by *Pseudocercosporella herpotrichoides* and septoria leaf and glume blotches caused by *Septoria tritici* and *S. nodorum.* Plants infested with take-all are commonly much more susceptible to Septoria.

For more information

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The authors acknowledge the contributions of the late Thomas L. Jackson. For over 30 years, Dr. Jackson promoted Oregon agriculture through practical scientific endeavors as professor of soil science at Oregon State University. In 1976, Dr. Jackson observed that wheat plots fertilized with ammonium chloride were less affected by take-all than were plots fertilized with other nitrogen sources. This observation was the starting point for research that developed the management program described in this publication. This publication replaces FS 250.

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